



MTO 26.1 Examples: Clayton, Theory and Practice of Long-form Non-isochronous Meters

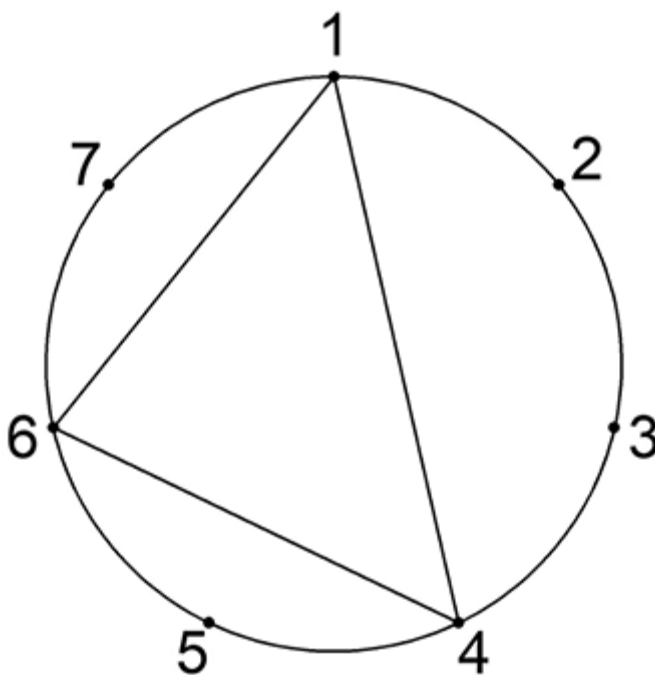
(Note: audio, video, and other interactive examples are only available online)

<https://mtosmt.org/issues/mto.20.26.1/mto.20.26.1.clayton.html>

Example 1. Groupings of seven subdivisions into 2, 3, and 4 beats (from top to bottom). Those in bold are *aksak* rhythms reported in the literature.

34			43	
322		{232}	223	
{1222}	{2122}	2212	{2221}	

Example 2. Representation of a (fast tempo) 3+2+2 metrical structure as a circle. The triangle represents the 3-cycle at the beat group level (after London 2012).



Example 3. Representation of a (fast tempo) 3+2+2 metrical structure according to Lerdahl and Jackendoff's (1983) notation. SD = Subdivision; B = Beat; M = Measure.

SD	•	•	•	•	•	•	•	•
B	•			•		•		•
M	•							•

Example 4. Proposed general constraints on the absolute durations of metrical cycles, beats, and subdivisions (columns a and b), and their implications for cycles of 7 subdivisions organized into 3 beats (columns c and d)

	General		7-cycle	
	<i>a. fastest</i>	<i>b. slowest</i>	<i>c. fastest</i>	<i>d. slowest</i>
Metrical cycle		<6sec, pref. <3sec	1400msec	2800msec
Beat	>400msec (<150bpm)	<1200msec (>50bpm)	S=400/ L=600msec	S=800/ L=1200msec
Subdivision (N-cycle pulses)	>100msec (<600bpm)		200msec (300bpm)	400msec (150bpm)

Example 5. *Rūpak tāl's thekā* (archetypal or basic drum pattern). The top line represents the clapping pattern, the bottom line the *ṭhekā*.

0 (wave)			1 (clap)		2 (clap)	
<i>Tin</i>	<i>Tin</i>	<i>Na</i>	<i>Dhin</i>	<i>Na</i>	<i>Dhin</i>	<i>Na</i>

Example 6. Recordings in *rūpak tāl* consulted. Corpus: C = Core, + = Additional; Tap: A = All, S = Start and end; Dur(s) = duration in seconds; harm. = harmonium, *sar.* = *sāraṅgī*.

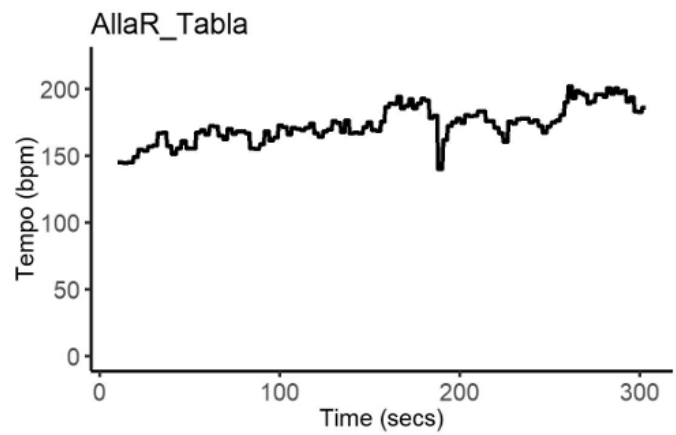
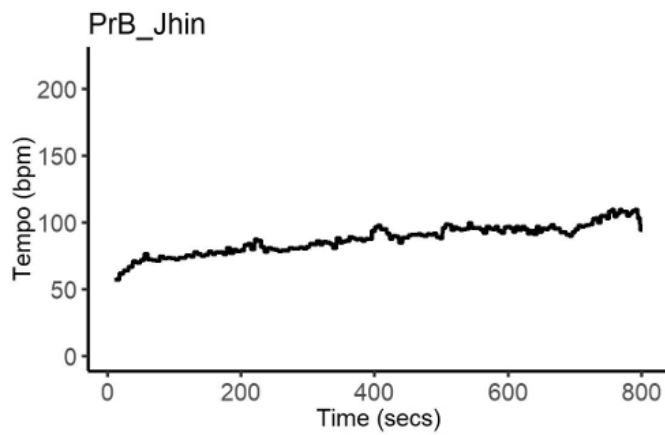
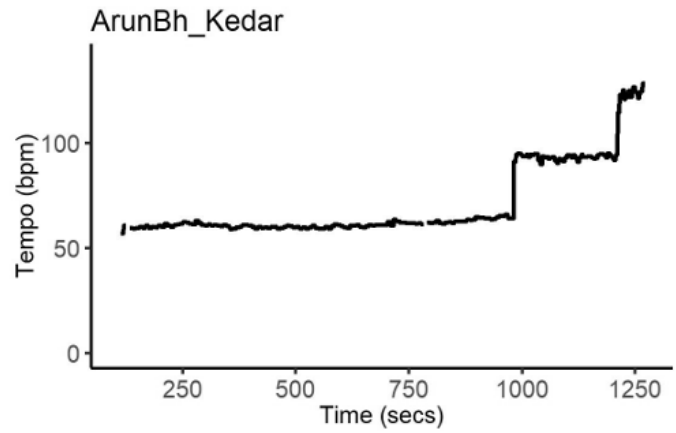
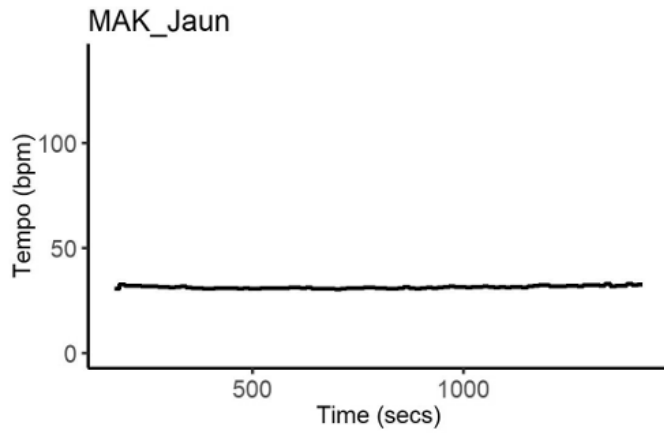
Code	C	T	Soloist	Tablā	Other	Rāga	Genre	Recording source	Dur	Start	End	Min	Max
AllaR_Tab	+	A	Alla Rakha (tablā)	n/a	Ravi Shankar (sitar)	n/a	Tablā solo	Music of India - Ragas and Talas, HMV ALP 1665 (1959). Amazon.com Song ID: 226339486	294	144.8	185.6	140.2	201.8
AmjAKh_Bhim	+	S	Amjad Ali Khan (sarod)	Abhijit Banerjee	n/a	Bhimpalāsī	Gat	India Archive Music IAM 1019 (2009)	642	92.1	112.6	87.9	120.9
AnuSh_Gang	+	A	Anoushka Shankar (sitar)	Tanmay Bose	n/a	Gangeśvarī	Gat	Shankar Ragamala, Music Today CD A-04200A/B/C (2004)	407	84.7	107.4	84.7	108.1
AraTh_Bihag	+	S	Arawind Thatte (harmonium)	Charudatta Phadke	n/a	Bihāg	Khyāl (harm.)	Private recording by permission of Dr Arawind D. Thatte	839	97.9	109.8	97.9	113.0
AraTh_NatBh	+	S	Arawind Thatte (harmonium)	Charudatta Phadke	n/a	Naṭ Bhairav	Khyāl (harm.)	Private recording by permission of Dr Arawind D. Thatte	1050	42.5	56.7	40.9	60.5
ArunBh_Kedar	C	A	Arun Bhaduri (voice)	Tarak Saha	Gourab Chatterjee (harm.)	Kedār	Khyāl	Raniganj, 14/2/2007	1169	56.9	128.2	56.9	128.4
AshBh_Nay	+	S	Ashwini Bhide-Deshpande (voice)	Viswanath Shirodkar	Seema Shirodkar (harm.)	Nāyaki Kānaḍā	Khyāl	Classical Vocal Vol. 2, Fountain Music FMRC014 (1997)	928	26	30.8	25.4	30.8
BasM_Nay	+	S	Basavi Mukherjee (voice)	Debashish Sarkar	Ramesh Mishra (sar.), Prosenjit Sengupta (harm.)	Nāyaki Kānaḍā	Khyāl	Eclectic Expression, P&M Records PMR048 (2006)	1103	22.9	24.3	22.4	24.7
BBhK_Maru	+	S	Brij Bhushan Kabra (guitar)	Kashinath Mishra	n/a	Māru Bihāg	Gat	Lure of the Desert, EMI CD PSLP 5233 (1990)	1617	91.4	100.1	90.7	106.7
BhimJ_LalitaG	+	S	Bhimsen Joshi (voice)	Shashikant Muley	Purushottam Walawalkar (harm.)	Lalitā Gaurī	Khyāl	Live at ICA July 28, 1985, Navras NRCD 0021 (1993)	446	31.2	55.8	30.9	57.4
DCh_Bhim	+	S	Deepak Choudhury (sitar)	Arup Chattopadhyay	n/a	Bhimpalāsī	Gat	London, October 6, 1991	1261	86.3	169.8	86.3	182.1

DCh_TilakK	+	S	Deepak Choudhury (sitar)	Arup Chattopadhyay	n/a	Tilak Kāmōd	Gat	Birmingham, September 17, 1991	974	86.3	165.3	86.3	170.5
DebBh_Bhim	+	S	Debashish Bhattacharya (guitar)	Samir Chatterjee	n/a	Bhimpalāsī	Gat	Hindustani Slide Guitar, India Archive Music IAM 1026 (1997)	1372	82.7	135.5	82.5	150.2
GSS_Amrit	+	S	G. S. Sachdev	Swapan Choudhuri	n/a	Amrit	Khyāl ()	Jasmine Nights, Audiorec ACCD 1033 (1998)	912	73.2	72.6	68.3	83.8
GSS_Kala	+	S	G. S. Sachdev	Zakir Hussein	n/a	Kalāvati	Khyāl ()	Spirit, Audiorec 1029 (1995)	560	75	93.1	72.3	98.1
KaIR_Multani	+	S	Kala Ramnath (violin)	Kumar Bose	n/a	Multāni	Khyāl (violin)	Luminous, Audiorec 1057-2 (2003)	1035	45.9	55.8	43.4	56.6
LatifAKh_Tabla	+	S	Latif Ahmed Khan (tablā)	n/a	Asif Ali Khan (sar.)	n/a	Tablā solo	Homage a Latif Ahmed Khan, AIMP XLV (Archives Internationales de Musique Populaire), VDE CD-909 (1996)	1254	65.9	220.1	61.5	229.2
LSh_Param1	+	A	Lakshmi Shankar (voice)	Bikram Ghosh	Tanmay Bose (swarmandal); Barry Phillips (cello)	Paramesvarī	Khyāl	Shankar Ragamala, Music Today CD A-04200A/B/C (2004)	342	98.3	107.9	96.0	119.0
LSh_Param2	+	S	Lakshmi Shankar (voice)	Aneesh Pradhan	Purushottam Walawalkar (harm.); Liyakat Ali Khan (sar.)	Paramesvarī	Khyāl	A Life of Dedication, Navras (2006)	564	108.1	118.2	104.2	120.3
LSh_Todi	+	S	Lakshmi Shankar (voice)	Aneesh Pradhan	Purushottam Walawalkar (harm.); Liyakat Ali Khan (sar.)	Toḍī	Khyāl	A Life of Dedication, Navras (2006)	568	58.5	71.8	51.7	75.7
MAK_Jaun	C	A	Manjiri Asanare-Kelkar (voice)	Milind Pote	Chinmay Kolhatka (harm.)	Jaunpurī	Khyāl	Pune, December 9, 2006	1041	30.7	32.9	30.6	33.1
MAK_Jhin	C	A	Manjiri Asanare-Kelkar (voice)	Milind Hingne	Shubhash Dasakkar (harm.)	Jhinjhotī	Khyāl	Nashik, February 13, 2011	884	39.2	37.3	34.9	39.2
MAK_TikakK	C	A	Manjiri Asanare-Kelkar	Vishwanath Shirodkar	Kaviraj Singh (harm.)	Tilak Kāmōd	Khyāl	Durham, 30/4/14	292	70.7	83.7	70.3	88.8

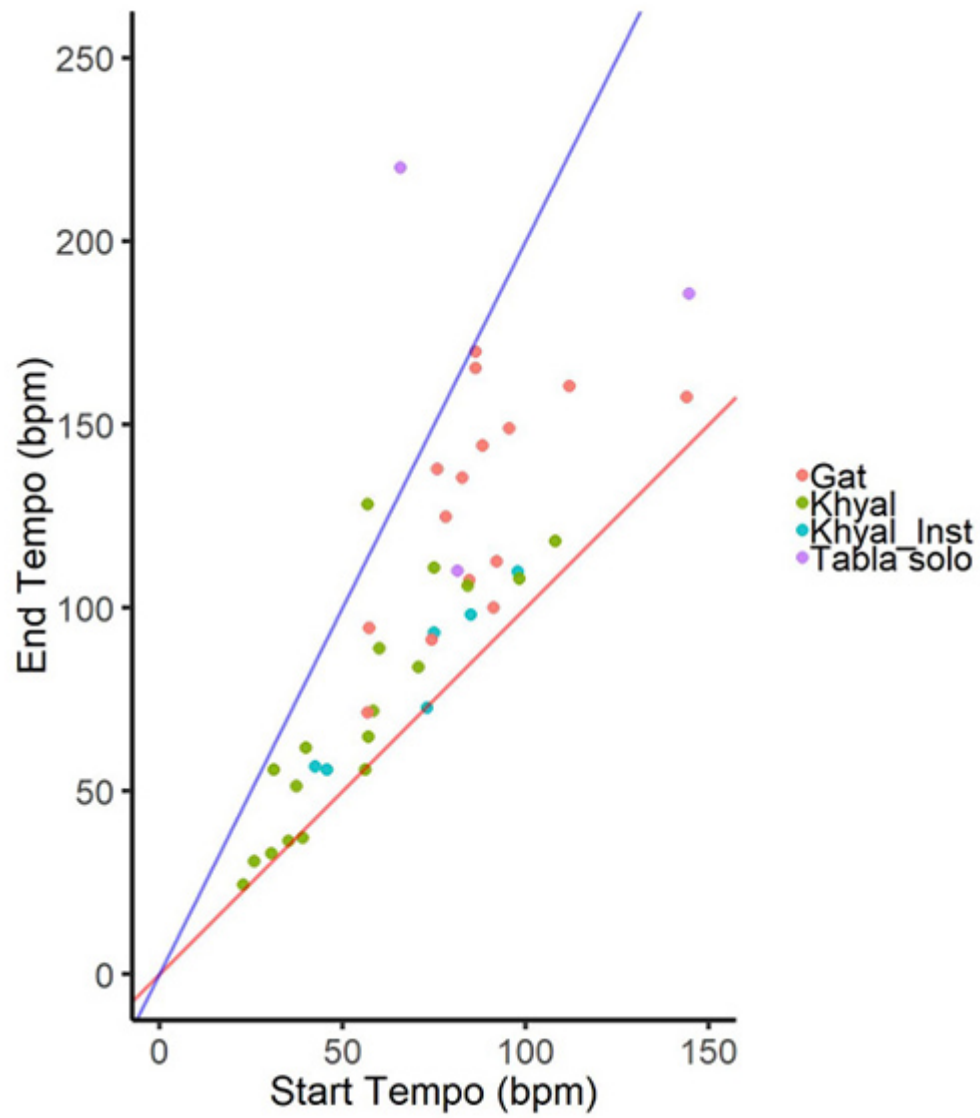
			(voice)										
MurA_DhaniK	C	A	Murad Ali (<i>sāraṅgī</i>)	Gurdain Rayatt	n/a	<i>Dhānī Kauns</i>	<i>Khyāl</i> (<i>Sāraṅgī</i>)	Gateshead, 24/9/12	916	85.1	98.1	85.2	102.1
NikhB_Bhim	+	S	Nikhil Banerjee (<i>sītār</i>)	Kanai Dutta	n/a	<i>Bhimpalāsī</i> [<i>Bhimpalasrī</i>]	<i>Gat</i>	Afternoon Ragas', Raga Records 211 (1970). Amazon.com Song ID: 203701735	792	75.9	137.9	75.5	142.4
PrB_Jhin	+	A	Prattyush Banerjee (<i>sarod</i>)	Gauri Shankar Karmakar	n/a	<i>Jhinjhotī</i>	<i>Gat</i>	Kolkata, 28/1/2007	961	57.3	94.4	57.3	109.7
RamD_RagBah	C	A	Ram Deshpande (voice)	Viswanath Shirodkar	Anant Lakhe (harm.)	<i>Rāgesrī-Bahar</i>	<i>Khyāl</i>	Nashik, 13/2/2010	313	37.4	51.4	36.0	55.2
RSh_Todi	+	A	Ravi Shankar (<i>sītār</i>)	Alla Rakha	n/a	<i>Toḍī</i>	<i>Gat</i>	Live At Monterey (1967), Amazon.com Song ID: 208637473	882	112	160.5	112.0	176.3
SAbh_Chandra	C	A	Sanjeev Abhyankar (voice)	Ajinkya Joshi	Tanmay Deochake (harm.)	<i>Candrakauns</i>	<i>Khyāl</i>	Gateshead 14/10/12	215	35.3	36.4	33.3	39.8
ShAKh_Janas	+	A	Shamim Ahmed Khan (<i>sītār</i>)	Yogesh Samshi	n/a	<i>Janasanmodini</i>	<i>Gat</i>	Shankar Ragamala, Music Today CD A- 04200A/B/C (2004)	869	144.1	157.4	142.0	167.4
ShivKSh_Gurj	+	S	Shiv Kumar Sharma (santoor)	Anindo Chatterjee	n/a	<i>Gurjari Toḍī</i>	<i>Gat</i>	A Morning Raga Gurjari Todi, Navras NRCD 0025(1993)	1319	88.3	144.2	84.6	149.0
ShivKSh_Puriya	+	S	Shiv Kumar Sharma (santoor)	Shafaat Ahmed Khan	n/a	<i>Pūriyā</i>	<i>Gat</i>	Navras NRCD 0060 (1996)	1231	78.2	124.9	78.2	136.3
ShPKh_Charu	+	S	Shahid Parvez Khan (<i>sītār</i>)	Hindol Majumdar	n/a	<i>Crukeśī</i>	<i>Gat</i>	Amazon.com Song ID: 243404211 (2013)	1197	56.8	71.4	56.5	78.4
ShPKh_Yaman	+	S	Shahid Parvez Khan (<i>sītār</i>)	Rajkumar Misra	n/a	<i>Yaman</i>	<i>Gat</i>	An Enchanting Evening With Ustad Shahid Parvez', Decca/ Universal (2009). Amazon.com Song ID: 219222141	939	74.4	91.2	72.5	107.3
ShrS_Bibhas	+	S	Shruti Sadolikar-	Anindo Chatterjee	Anand Kunte (sar.)	<i>Bibhās</i>	<i>Khyāl</i>	Nimbus Records NI 5346 (1992)	1169	57.2	64.8	55.4	64.8

			Katkar (voice)										
ShS_Tablā	+	A	Dharambir Singh (<i>sītār</i>), Kaviraj Singh (<i>santūr</i>)	Upneet Singh	n/a	<i>Śuddh Basant</i>	<i>Gat</i>	Durham, 22/4/13	887	95.5	149	94.4	164.3
Singh_Basant	+	S	Sharda Sahai (<i>tablā</i>)	n/a	Ramesh Mishra (sar.)	n/a	<i>Tablā solo</i>	The Spirit of Benares, Audiorec 1044-2 (1990)	1065	81.4	110	74.4	112.3
UlhasK_Hindol	+	S	Ulhas Kashalkar (voice)	Anand Gopal Bandopadhyaya	Jyoti Guho (harm.)	<i>Hinḍol</i>	<i>Khyāl</i>	Life at the Kufa Gallery, Navras NRCD 0107 (1996)	861	75	110.9	74.1	122.6
VK_HindBah	C	A	Vijay Koparkar (voice)	Ajinkya Joshi	Rahul Gole (harm.)	<i>Hinḍol-Bahār</i>	<i>Khyāl</i>	Pune, 25/2/2010	601	60.1	88.9	60.1	91.3
VK_RagK	C	A	Vijay Koparkar (voice)	Ajinkya Joshi	Rahul Gole (harm.)	<i>Rāgesrī-Kauns</i>	<i>Khyāl</i>	Pune, 25/2/2010	2078	40	61.8	37.3	64.7
VS_Hams	C	A	Veena Sahasrabuddhe (voice)	Viswanath Shirodkar	Seema Shirodkar (harm.)	<i>Hamsadhvani</i>	<i>Khyāl</i>	Pune, 15/12/2006	797	56.3	55.9	54.0	57.1
VS_Shree	+	S	Veena Sahasrabuddhe (voice)	Vinayak S. Phatak	Pramod Marathe (harm.)	<i>Śrī</i>	<i>Khyāl</i>	The Emerging Stylist', Rhythm House Classic 240 355 (1987)	565	84.3	106.1	83.5	111.4

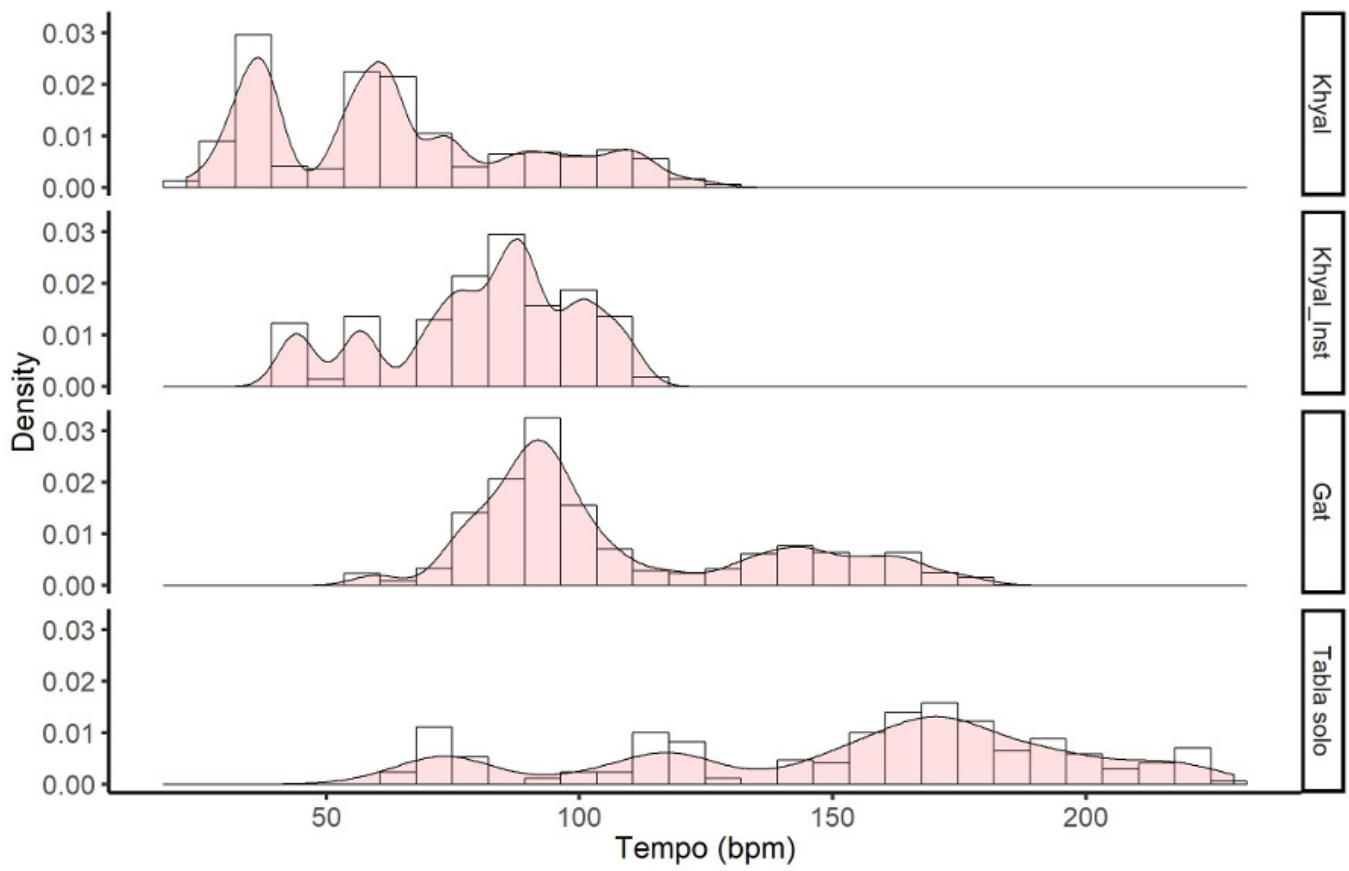
Example 7. Tempo curves for four representative performances in *rūpak tāl*. Three of the charts are based on *tablā* onset data. AllaR_Tabla is based on manual tapping data. The phrase relationship between *tablā* solo and *sitār* accompaniment is reset just before 200 secs.



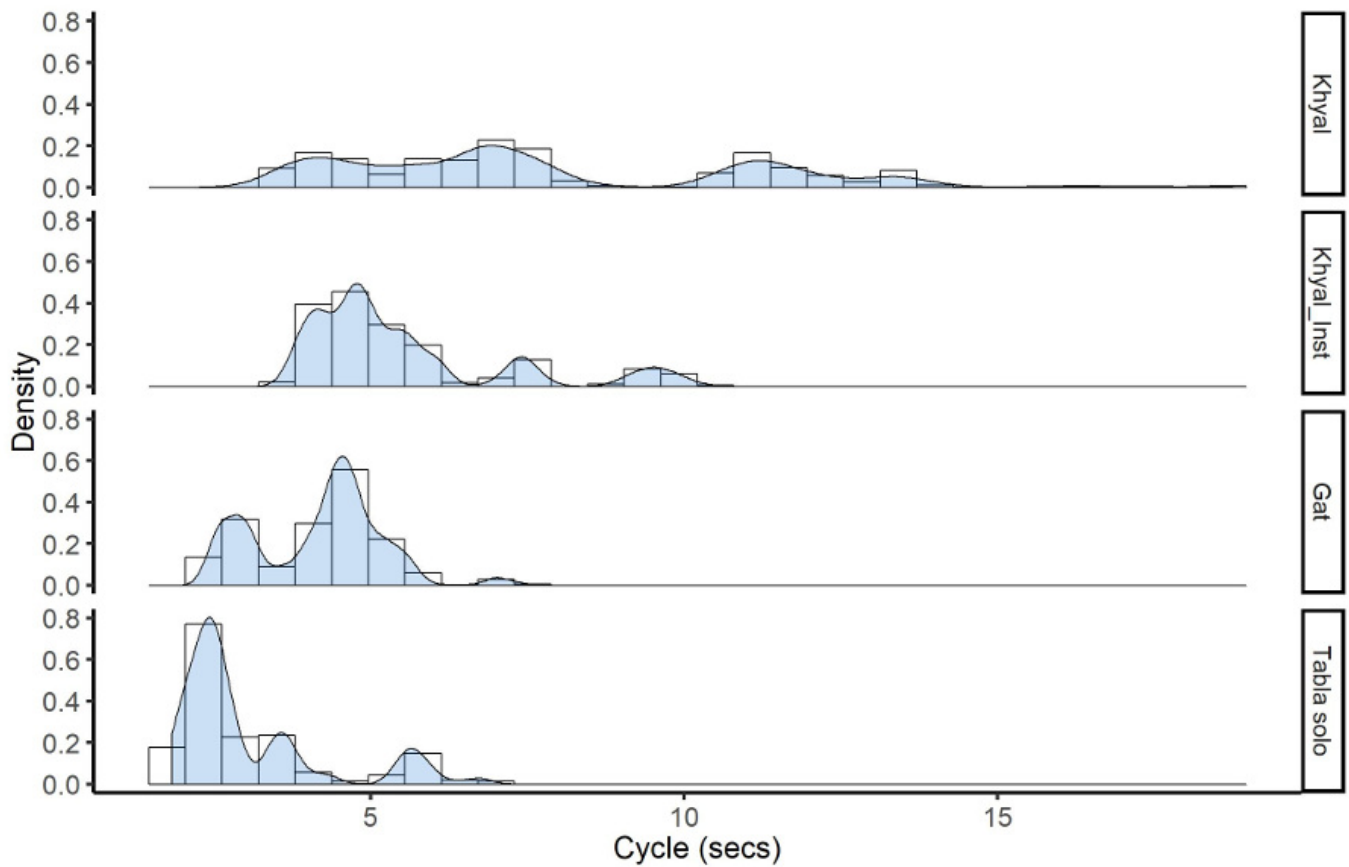
Example 8. Start vs. end tempo for 42 recordings in *rūpak tāl*. Red line: $y = x$ (constant tempo); blue line: $y = 2x$ (tempo doubles).



Example 9. Tempo histograms/ density plots by genre



Example 10. Cycle length histograms/ density plots by genre



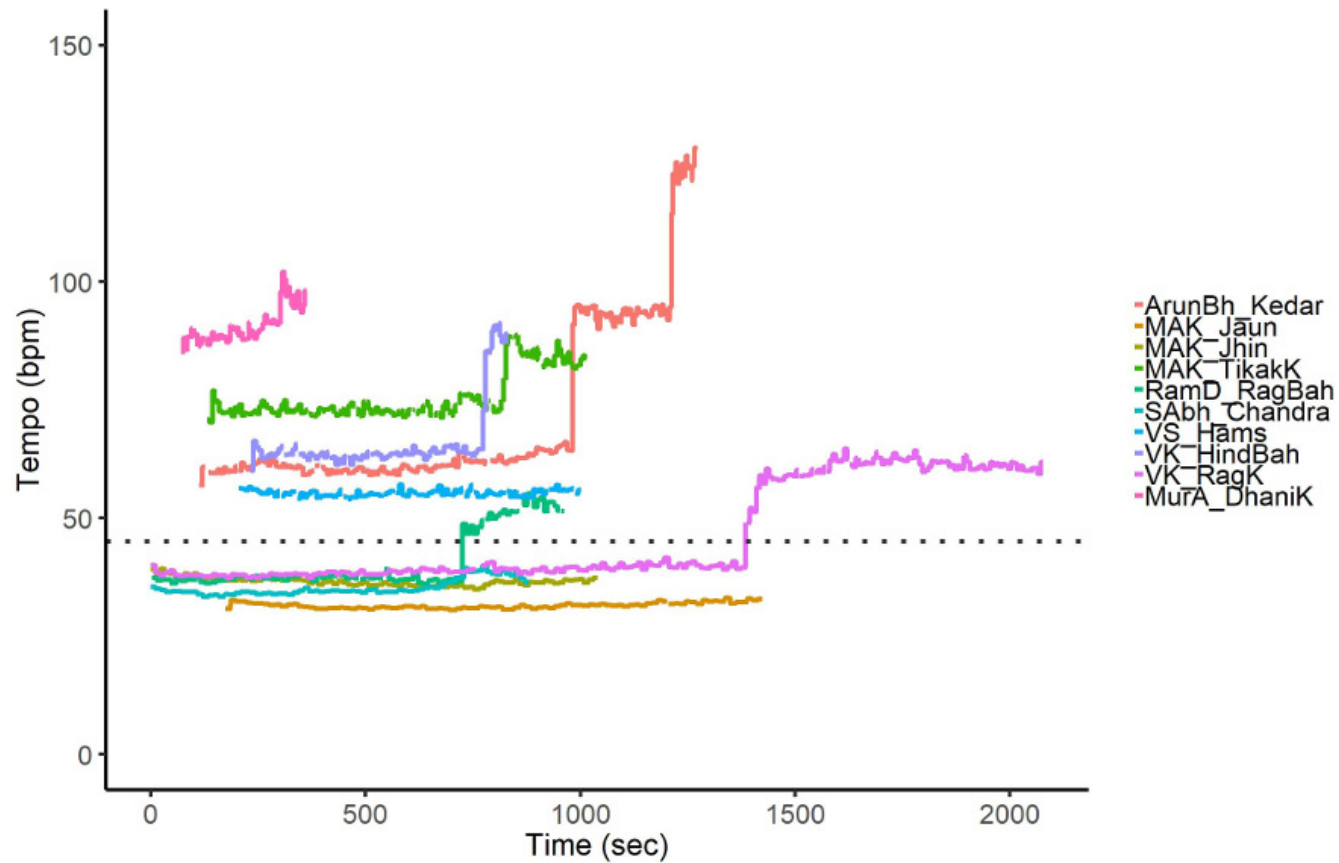
Example 11. *Rūpak tāl thekā* versions. Top line = basic pattern; lines 2–5, variants noted by Magriel and du Perron (2013, vol. 1, 269); lines 6–7, “solo and accompaniment” *thekās*, adapted from Nainpalli 2005, 180.

	0			1		2	
Basic	<i>Tin</i>	<i>Tin</i>	<i>Na</i>	<i>Dhin</i>	<i>Na</i>	<i>Dhin</i>	<i>Na</i>
Magriel variants					<i>Dha</i>		<i>Dha</i>
							<i>Dha</i>
					[unsounded]		
Nainpalli thekās			<i>Tirakita</i>				
	<i>Tin - - kra</i>	<i>Tin - Tin</i>	<i>Ta – Tit -</i>		<i>Dha Ge</i>		<i>Dha Dha</i>
		<i>Tin – Na -</i>	<i>Tirakita</i>		<i>Tirakita</i>		

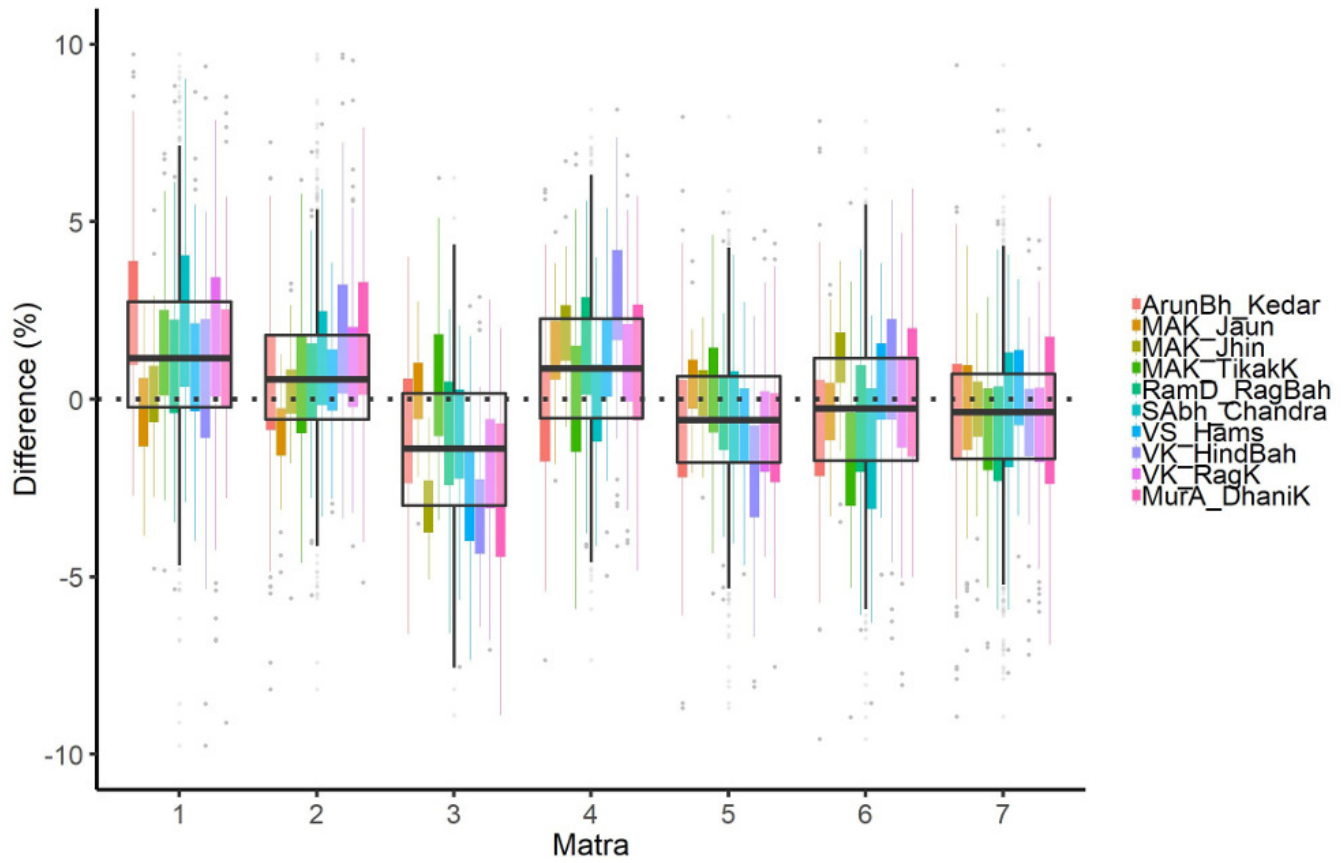
Example 12. Ten recordings comprising the core corpus used in the second stage analysis. Dur = duration (secs); Start = starting tempo (bpm); End = ending tempo (bpm); Min = Minimum tempo (bpm); Max = Maximum tempo (bpm; N = number of selected *tablā* onsets).

Code	Soloist	<i>Rāga</i>	Dur	Start	End	Min	Max	Onsets
ArunBh_Kedar	Arun Bhaduri	<i>Kedār</i>	1169	56.9	128.2	56.9	128.4	1364
MAK_Jaun	Manjiri Asanare-Kelkar	<i>Jaunpurī</i>	1041	30.7	32.9	30.6	33.1	655
MAK_Jhin	Manjiri Asanare-Kelkar	<i>Jhinjhotī</i>	884	39.2	37.3	34.9	39.2	634
MAK_TikakK	Manjiri Asanare-Kelkar	<i>Tilak Kāmod</i>	292	70.7	83.7	70.3	88.8	1031
MurA_DhaniK	Murad Ali	<i>Dhānī Kauns</i>	916	85.1	98.1	85.2	102.1	426
RamD_RagBah	Ram Deshpande	<i>Rāgeśrī-Bahār</i>	313	37.4	51.4	36.0	55.2	639
SAbh_Chandra	Sanjeev Abhyankar	<i>Candrakauns</i>	215	35.3	36.4	33.3	39.8	518
VK_HindBah	Vijay Koparkar	<i>Hinḍol-Bahār</i>	601	60.1	88.9	60.1	91.3	645
VK_RagK	Vijay Koparkar	<i>Rāgeshree-Kauns</i>	2078	40	61.8	37.3	64.7	1579
VS_Hams	Veena Sahasrabuddhe	<i>Hamsadhvani</i>	797	56.3	55.9	54.0	57.1	708

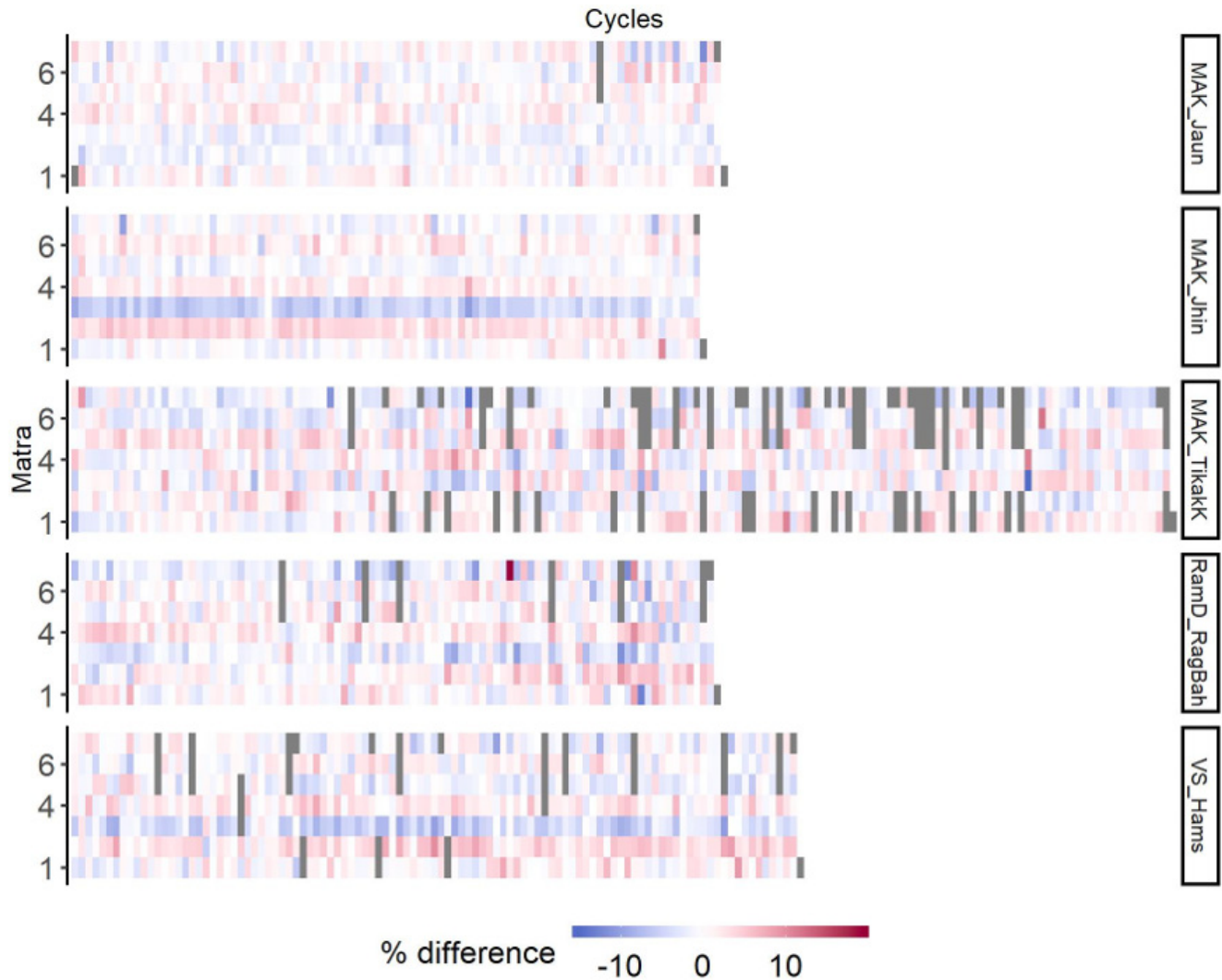
Example 13. Tempo curves for all ten core recordings, based on *tablā* onset data. The horizontal line indicates 45 bpm.



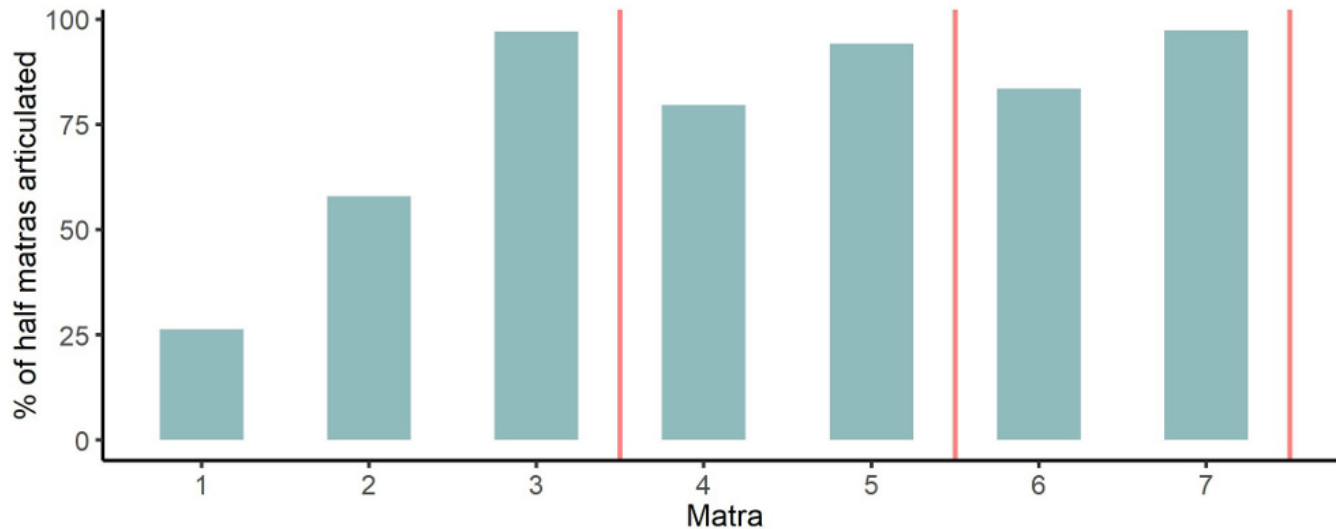
Example 14. Difference in *mātrā* lengths from isochrony. Black boxes indicate the overall distribution in the corpus, and colored boxes indicate the individual recordings. Outliers (values with a magnitude >10%) are excluded from the chart for ease of reading.



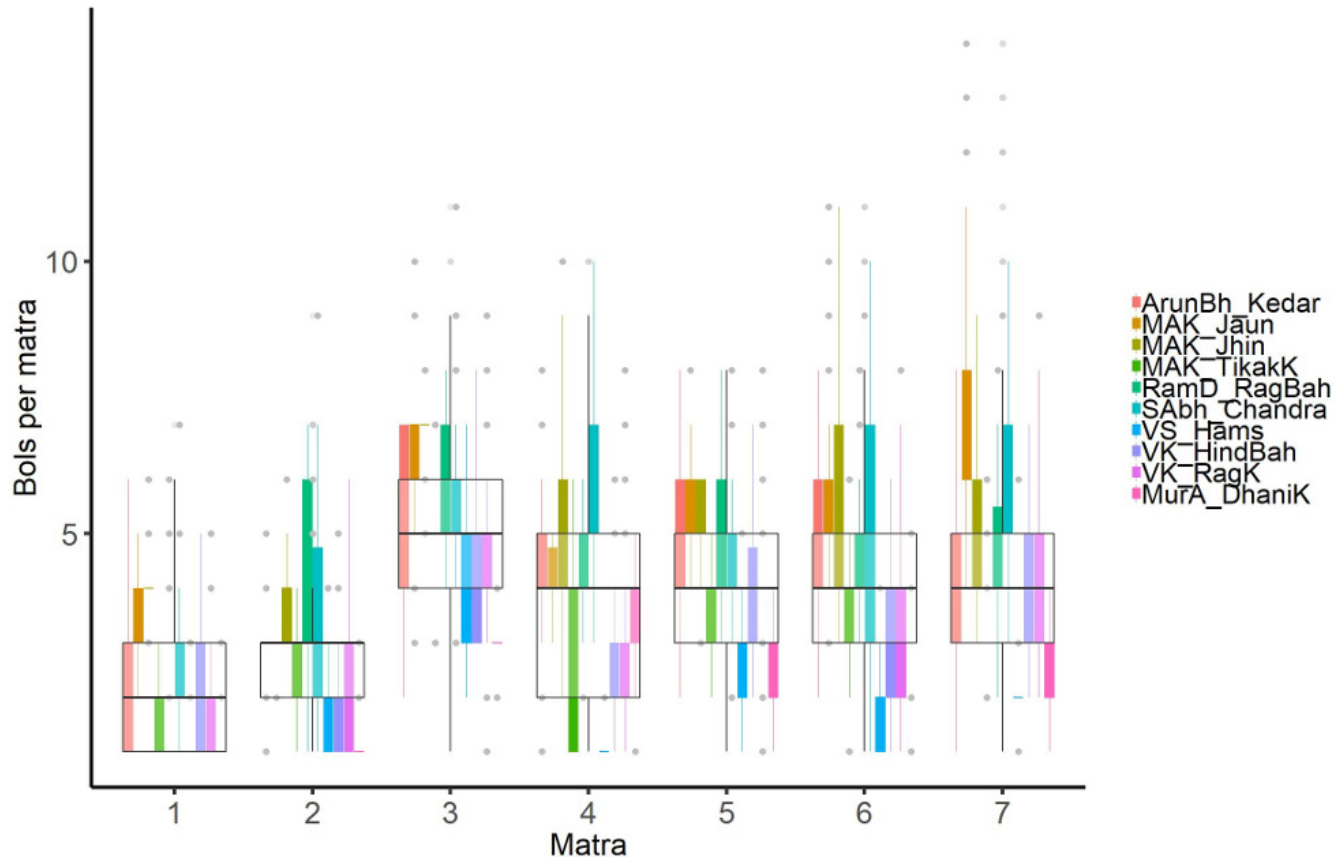
Example 15. Plot of differences in *mātrā* length from isochrony in four *khyāl* performances. Blue tiles indicate *mātrās* shorter than the equal subdivision of the cycle, and red tiles indicate *mātrās* longer than the equal subdivision of the cycle. Grey = missing data. Time runs left to right, with each column representing one cycle. The *mātrās* are represented in rows, from 1 at the bottom to 7 at the top.



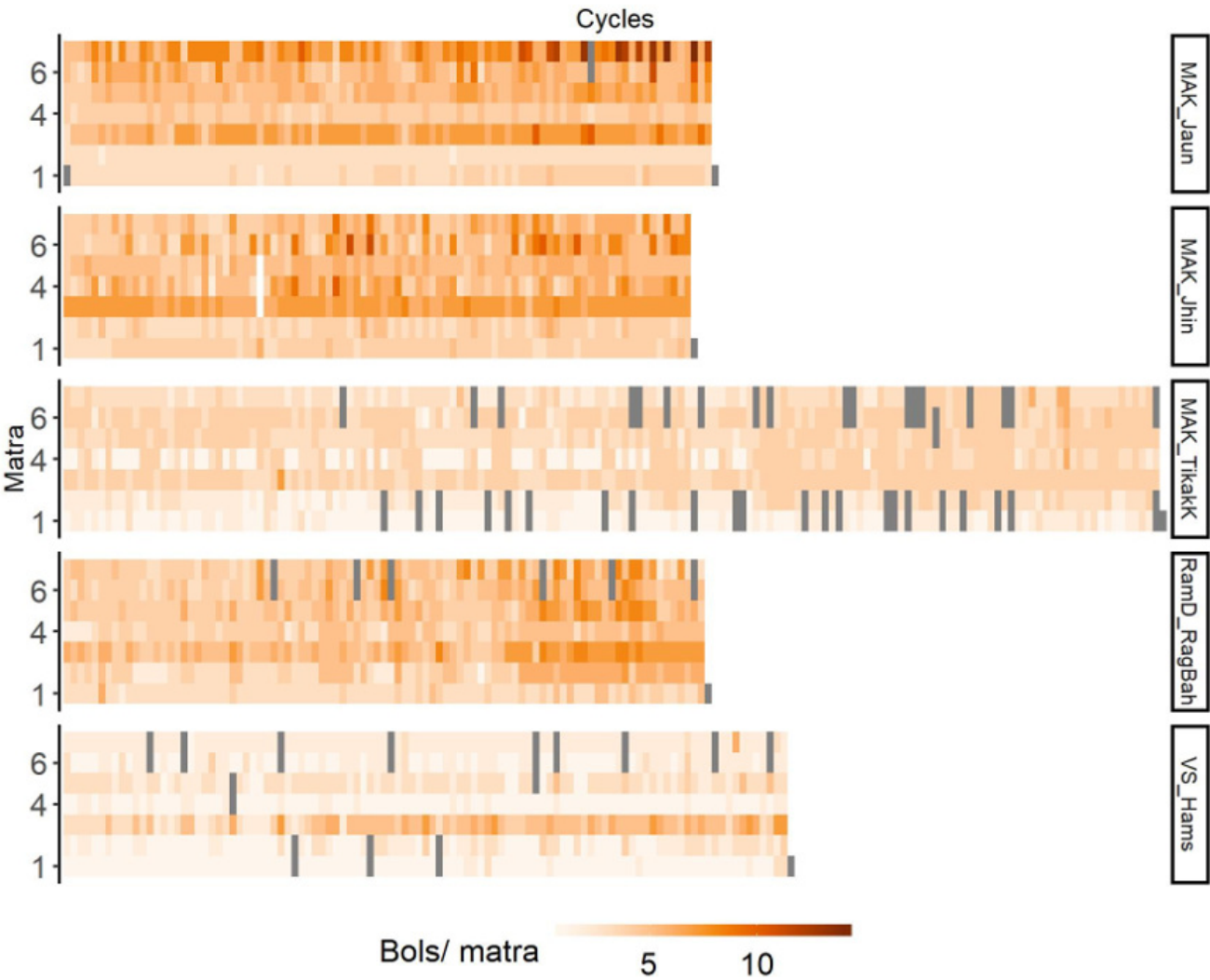
Example 16. The proportion of beats in each *mātrā* position featuring a *tablā* stroke at the half-*mātrā* position. Vertical red lines indicate the group (*vibhāg*) divisions.



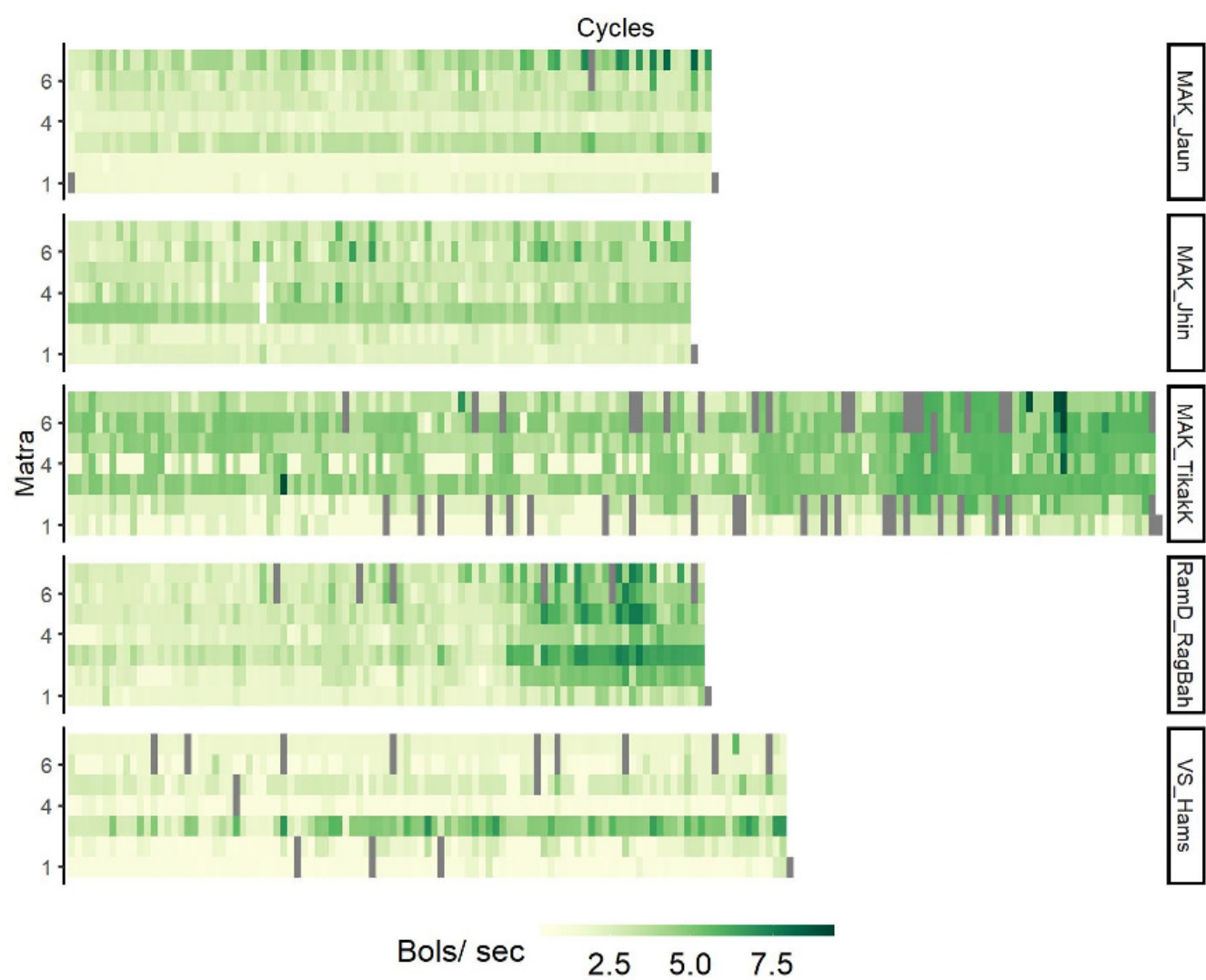
Example 17. The number of detected *tablā* onsets (*bols*) per beat by *mātrā* position



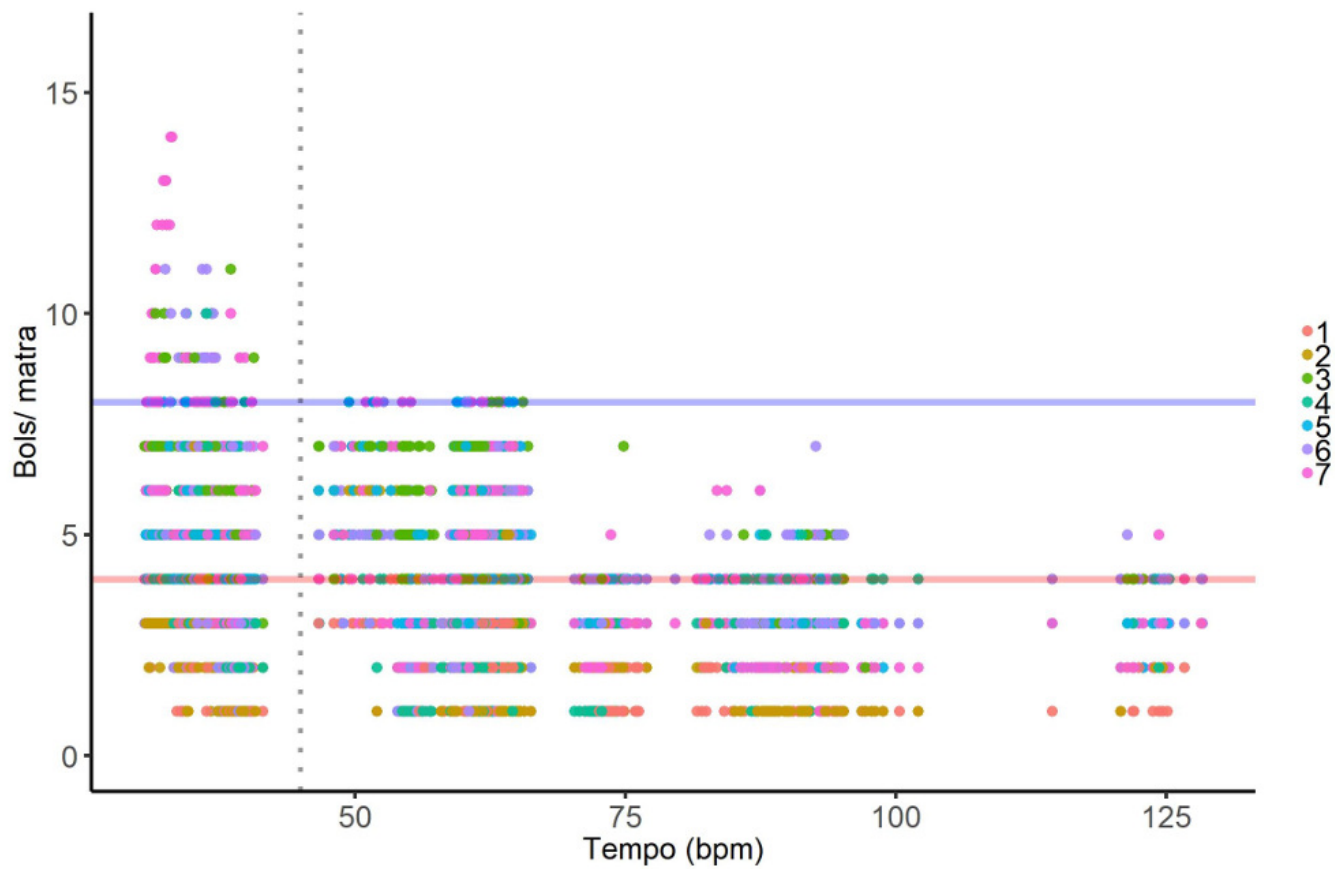
Example 18. Strokes (*bols*) per *mātrā* across five performances



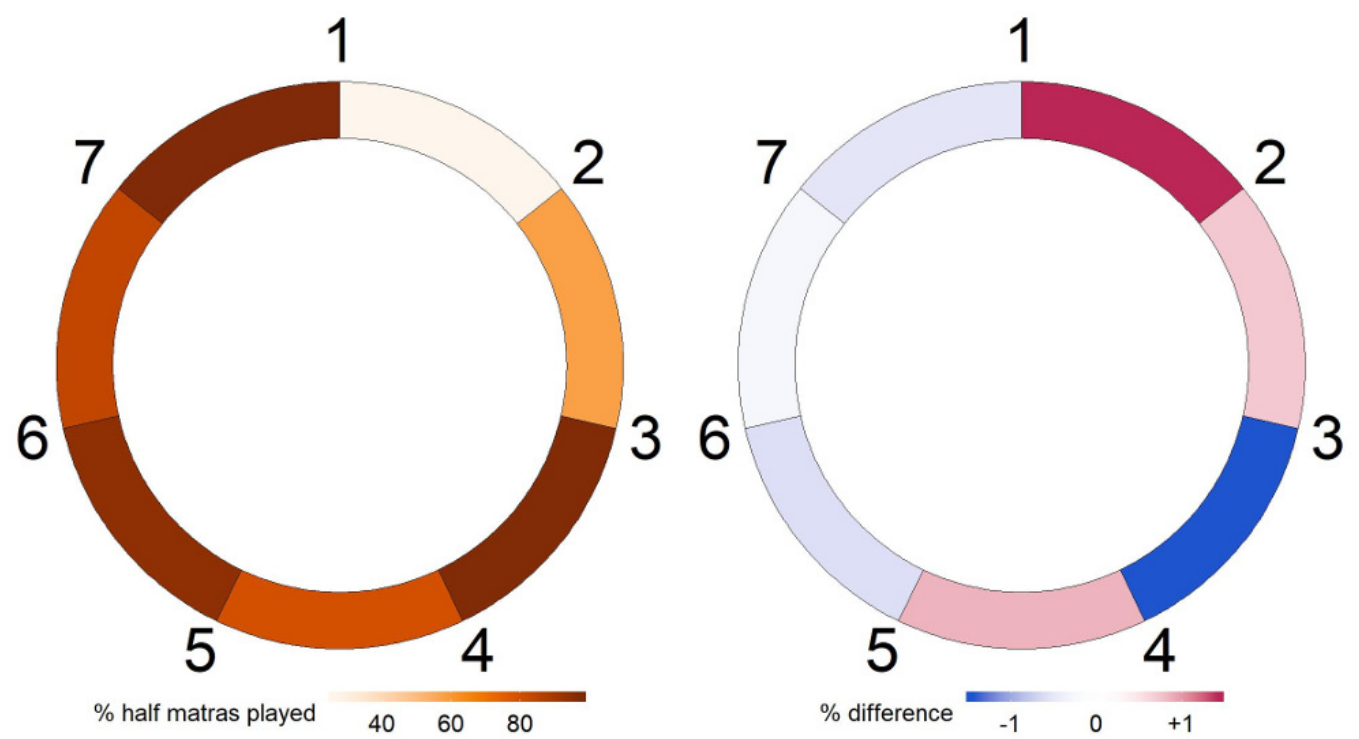
Example 19. Stroke density per second across five performances



Example 20. Distribution of number of *bols* (detected *tablā* onsets) per *mātrā* by tempo. *Mātrā* numbers are indicated by color: red line = 4:1, blue line = 8:1. Grey dotted line = 45 bpm.



Example 21. *Rūpak tāl*'s structure, featuring mean percentages of half-*mātrā* positions articulated by the *tablā* (left), and mean percentage differences from isochrony (right).



Example 22. A representation of *rūpak tāl*'s structure, taking into account empirical findings on *mātrā* subdivision and variation in *mātrā* lengths

